



ESRI Comment Paper Regarding the National Animal Identification System

Eradication and Surveillance Team, APHIS
July 6, 2005

Prepared for:

Neil Hammerschmidt, Animal Identification Officer
Eradication and Surveillance Team, APHIS
4700 River Road Unit 43
Riverdale, MD 20737-1231
(301) 734-5571

Prepared by:

Environmental Systems Research Institute, Inc. (ESRI)
380 New York Street
Redlands, California 92373-8100
Phone: (909) 793-2853

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Executive Summary

Understanding the Problem

The public demand placed on government agriculture workers to protect our nation's food supply has greatly intensified. The threat of disease outbreaks places an increasing demand to develop a National Animal Identification System (NAIS) as a necessary component of our nation's agricultural infrastructure. The plan from the United States Department of Agriculture (USDA) to initiate and support NAIS offers a unique opportunity to develop a system that protects animal health while protecting the public.

NAIS opens the dialog among government, food producers, and citizens regarding the importance of protecting our nation's food and fiber infrastructure. It is especially important to continue to understand, mitigate, and respond to threats to food supplies whether they are derived from unintentional or deliberate disease outbreaks.

The implementation of NAIS provides an opportunity for tribal, state, and local governments to develop innovative approaches to control, eradicate, monitor, and survey animal diseases. As solutions to the quick identification of disease outbreaks and response mechanisms are explored, it is important to learn from organizations that have had to deal with similar initiatives.

Accurate, reliable information for all of the premise types associated with food production forms a necessary foundation of the information required for tracking animals as they move through these premises. A successful NAIS will be an integrated network of data repositories, managed and operated at all levels of government that constantly gathers the data required to monitor the movement of animals through the agricultural community.

ESRI strongly believes that additional geographical data and application standards are required to ensure that animal movements can be accurately tracked. In addition, ESRI believes that, once captured, the management of vast volumes of animal movement and premises information can only be met through the use of GIS technology. The solution to enhance NAIS is three-fold:

- The standardization of address and parcel data through the provisioning and use of a common web service to be utilized by USDA/APHIS, states, and third party service providers;
- The development of an Animal Movement and Analysis System (AMAS) that can track animal movements in a scalable way, providing analysis and decision support in concert with the indications, occurrences, and transmissions of disease during agricultural emergencies; and
- The support of a broader Animal Health Surveillance System (AHSS) that utilizes premises and animal movement information as part of a larger information system that integrates laboratory and field information, exchanges information with other response agencies, alerts the agricultural community, and provides information to the public.

Why GIS?

GIS technology has the capability to track the movement of animals through regulated premise locations, both within and across various government jurisdictions, on a national scale. The sheer volume of movement information that will be processed on a daily basis will be unmanageable without the use of GIS technology.

In the event of disease outbreaks as a result of natural or intentional acts, the information available through NAIS, combined with criminal investigation and disease outbreak data, will be necessary for a rapid and thorough assessment and response. Geography plays a major role in understanding the dynamics of a disease outbreak or terrorism event in the food and fiber sector. The methodologies used in determining the causes and predicting the impact of these events include visualizing where an outbreak or event

originated, tracing animal populations and their distribution in relation to these events, and determining risk to both human and animal populations, and the proper course of action to protect both.

ESRI GIS products and solutions can immediately support the development of NAIS. ArcWeb Services can provide a common web service for use within USDA/APHIS, State Governments, and other USDA agencies and partners such as the Food Safety Inspection Service, the Food and Drug Administration, and the Department of Homeland Security. States choosing to develop their own State Premises Registration System (SPRS) can be required by USDA/APHIS to utilize this web service, for the purpose of standardizing addresses, providing latitude and longitude coordinates for these addresses (geocoding), and identifying rural locations where addresses are not readily available for geocoding. ArcSDE can be deployed to spatially enable the National Premises Information Repository (NPIR), effectively managing the high volume of address, coordinate, and boundary data associated with registered premises. ArcGIS Schematics can be used to develop the Animal Movement and Analysis System, based upon its powerful capacity to visually display complex, multi-node relationships in a graphical interface, providing analysis and decision support in concert with the indications, occurrences, and transmissions of disease during agricultural emergencies. A more detailed description of the ESRI GIS products discussed above can be found in Appendix A.

All of the above products can be integrated into an overall Animal Health Surveillance System, alerting response partners during an event, and sharing analyses and information between jurisdictions for an integrated response as well as with the public.

Whether it is the creation, storage and retrieval of base maps, the ability to summarize and analyze this information using a map and schematic interface, or the sharing of data and spatial analyses between jurisdictions, GIS software is required to make this effort a success on a national scale.

Benefits of GIS for USDA and NAIS

GIS at USDA

Since 2001, USDA has been implementing a Department-Wide Site License for ESRI GIS products and as a result GIS implementations at USDA are vast and far-reaching. USDA views GIS as technology that can help make large increases in productivity and improvements in customer service. Most of the business activities of USDA and partner agencies are associated with the geographic characteristics and related data on soil, water, air, plants, animals, land ownership, demographics, and socioeconomics.

As a result, NAIS can leverage existing applications and data layers from other USDA Agencies and Offices such as cadastre (Common Land Unit), soils (Web Soil Survey via Web Services), weather and climate, hydrologic, infrastructure, demographics and statistics, as well as modeling and analysis tools. The solutions are interoperable, flexible, and scalable for current and future needs.

Common Operating Picture GIS Enabled Supporting Agriculture/Food Security Missions

GIS provides a foundation for the development of an interoperable Common Operating Picture (COP) by the Department of Agriculture, for use by state agriculture agencies, utilizing the information collected by NAIS. In addition, the COP architecture could be extended and incorporated into other homeland security and health response activities. It would be employable and interoperable within the Department, states, ISACs, DHS entities, and other stakeholders. It would support Department of Agriculture's food, agriculture, and health responsibilities in HLS-related initiatives for border and transportation security, defense against catastrophic threats, emergency preparedness and response, and protection of critical infrastructure efforts.

Data Privacy and Security

Maintaining the appropriate level of data access and enduring privacy within NAIS is a primary concern shared by USDA/APHIS, state Departments of Agriculture, and the agricultural industry. The establishment of customizable security controls within ESRI's ArcGIS product through ArcObjects, in

combination with the security controls provided within the RDBMS used within NAIS for both NPIR and NARR, is a large component of an overall multi-layered security approach that ensures the privacy of participating NAIS premises. ArcWeb Services provided both to USDA/APHIS and state systems are deployable in accordance with standard web services security practices. A more detailed description of how ESRI products can be securely deployed as part of an integrated security strategy can be found at www.ESRI.com.

Summary Approach

ESRI proposes the implementation of three GIS system components into the overall NAIS architectural solution as follows:

Premises Address and Location Service (PALS)

Animal Movement and Analysis System (AMAS)

Animal Health Surveillance System (AHSS)

ESRI believes that each of these components is essential to ensuring that NAIS meets its overall objective of tracking all animal movements from birth to slaughter as part of USDA's National Animal Health Monitoring and Surveillance Program. The following is a more detailed discussion of each of these components and specifically why they are so critical to the success of NAIS.

Premises Address and Location Service

Within NAIS, premises location is the core information that will be used by NAIS to track animal movements. In the current NAIS approach, it is the responsibility of each state jurisdiction to provide accurate and reliable location information for each registered premises. Under NAIS, states can develop their own premises registration system, requiring USDA/APHIS certification (Certified Premises Registration System, or CPRS). Alternatively, USDA/APHIS will provide a standard premises registration system for use by states (Standardized Premises Registration System, or SPRS). SPRS, and multiple CPRS, will all be required to obtain a unique ID number for each premise, through a USDA/APHIS managed system that generates the unique ID, called the Premises Number Allocator.

Premises Number Allocator

The uniqueness of each unique ID, or Premises Identification Number (PIN), would be achieved through the Premises Number Allocator, with which the Premises Registration Systems (SPRS and CPRS) would interface when administering the registration of premises. NAIS requirements currently specify the provision of valid address information or legal land description by the state prior to receiving a PIN from the Premises Number Allocator. This is required in an attempt to avoid having multiple numbers assigned to the same operation, regardless of species.

ESRI recognizes the critical need for standard location coordinate information associated with the creation of a PIN for registered premises. Accurate and reliable animal tracking capability depends on the utilization of location information in a standard way.

One of the major challenges is that many premises are found on rural routes where there is no address that can be reliably ascertained for a property. Also, given the size of some registered operations, and the segmentation of different regulated activities associated with a particular premises, there are risks that multiple PINs can be assigned to the same operation. Other complicating issues include the use of mailing addresses for business correspondence which may not coincide geographically with a premises location, the management of multiple locations and location types by individual producers and non-producers, and the different methods for geo-coding addresses across state programs that may result in different address standards, different coordinates for the same premises, or multiple premises registered at the same physical location.

In the NAIS model, the states bear the responsibility of providing accurate and reliable location information for premises at the time of registration. In order to ensure standard location reporting and mitigate many of the issues discussed above, ESRI proposes the standard use of a set of web services that would be used by both SPRS, and the multiple CPRS. These web services would standardize address data capture, assign lat-long coordinate for each address, and provide common tools to identify coordinates when address information is unavailable or not reliable.

Address Standardization Web Service

A common web service that would normalize submitted addresses as part of the Premises Number Allocator submission process, and return standard address information to both SPRS and CPRS associated with a PIN.

Geocoding Web Service

A common web service that would receive address information, and return latitude-longitude (or other standard coordinate reference system) coordinates for the submitted address to SPRS and CPRS. This service will be used in conjunction with the address standardization service above, associating the resulting coordinates with the PIN.

Point/Polygon Mapping Service

A point/polygon mapping service would provide SPRS and CPRS users the ability to locate a location on a map, and to assign either a point or parcel boundaries. This service would use available raster images (aerial photography and/or satellite imagery) and associated map layers to help in determining where to draw a point or polygon on a map. This service would assign, to a unique ID, coordinates for a point location, and a set of coordinates as well as a shape file for parcel boundaries, and return this data to SPRS and CPRS.

ESRI can provide access to the above common services, managing the infrastructure required to keep these transaction services available to all states, through ArcWeb Services. Hosting these services by ESRI eliminates the need for USDA/APHIS to develop and support this capacity independently. Alternatively, ESRI can assist USDA/APHIS in becoming a direct provider of these services. What is most important is that there is a common mechanism across state participants for address and location handling.

USDA is already working to support the Federal Enterprise Architecture initiative set out in the E-Government Act of 2002 by building an enterprise information architecture for the Department of Agriculture that adheres to the FEA reference model. The intent of the E-Government Act is to ensure the federal government focuses information technology investments to deliver more effective results for citizens. To this end, FEA recommends a Service Oriented Architecture (SOA) approach for enterprise (IT) implementations.

The office of the Chief Information Officer at USDA has identified an application requirement within USDA to deliver live Web-based facility information in support of the USDA homeland security mission. This includes the publishing of facility information as a secure Web service to the Department of Homeland Security. USDA may want to consider the incorporation of the above described services as part of an enterprise USDA web services strategy for handling facilities and premises.

Developing an NAIS Geodatabase

The current NAIS data model, and in particular the data model for SPRS and NPIR, is insufficient to ensure accurate and reliable location information for animal tracking during disease outbreaks and emergency events. This can be summarized as three issues:

1. Data elements for address information are not in an appropriate format that facilitates standardization and geocoding. Standard methods for lat-long coordinate capture associated with an address are not provided.

Street address data specifications should, at a minimum, include separate fields for street number, street name, and street suffix, with a standard drop down list for street suffix. This will facilitate geocoding efforts.

The data elements for both SPRS and CPRS include fields for latitude and longitude GPS coordinates. However, standards rules should be established for how GPS is to be captured. Current GPS coordinate capture can vary from field capture of a single coordinate, field capture of multiple coordinates, geocoding using street centerline, geocoding using parcel centroid, or can be obtained by other methods. Standard methods for GPS capture become essential when this data will be used to determine the uniqueness of rural facilities where a street address is not available.

This is not a standard format that lends itself to accurate geocoding

Premises Registration Systems - Data Elements		
Field Name	Type	Length
Premises Identification Number	Alphanumeric	7
Name of Entity	Alphanumeric	30
Owner or Appropriate Contact Person*	Alphanumeric	30
Street Address	Alphanumeric	30
City	Alphanumeric	20
State	Alpha	2
Zip/Postal Code	Numeric	9
Contact Phone Number	Numeric	15
Operation Type	Character	1
Date Activated	Date (YYYYMMDD)	8
Date Retired	Date (YYYYMMDD)	8
Reason Retired	Character	1
Historic Data**		
Previous Contact Person	Alphanumeric	30
Previous Contact Person Phone	Numeric	15
Previous Contact Person - Start Date	Date (YYYYMMDD)	8
Previous Contact Person - End Date	Date (YYYYMMDD)	8
GPS		
Longitude	Numeric (6 decimals)	11
Latitude	Numeric (6 decimals)	11
Alternative Phone Numbers **	Numeric	15
* The contact person should be the person with whom the animal health official is to communicate when performing a traceback (as determined by the entity).		
** Requires facility to store multiple records.		

How do you ensure where the coordinate is taken. How do you ensure that it is unique for a particular address?

Table 4

(NAIS Draft Program Standards, A Discussion Document, 4/25/05.
http://animalid.aphis.usda.gov/nais/about/pdf/NAIS_Draft_Program_Standards_42505.pdf)

2. Lat-Long coordinates are not included elements of NPIR.

During a disease outbreak or an emergency, USDA/APHIS would not have the location coordinates available within the central NPIR to map or otherwise accurately represent animal movements. Combined

with incomplete address standardization, efforts to map animal movements would be difficult at best, and likely unsuccessful.

3. The capacity to store address updates in "stacked" or versioned format for historical retention of address information is not provided, nor is the ability to store and manage multi-point location data or shape files.

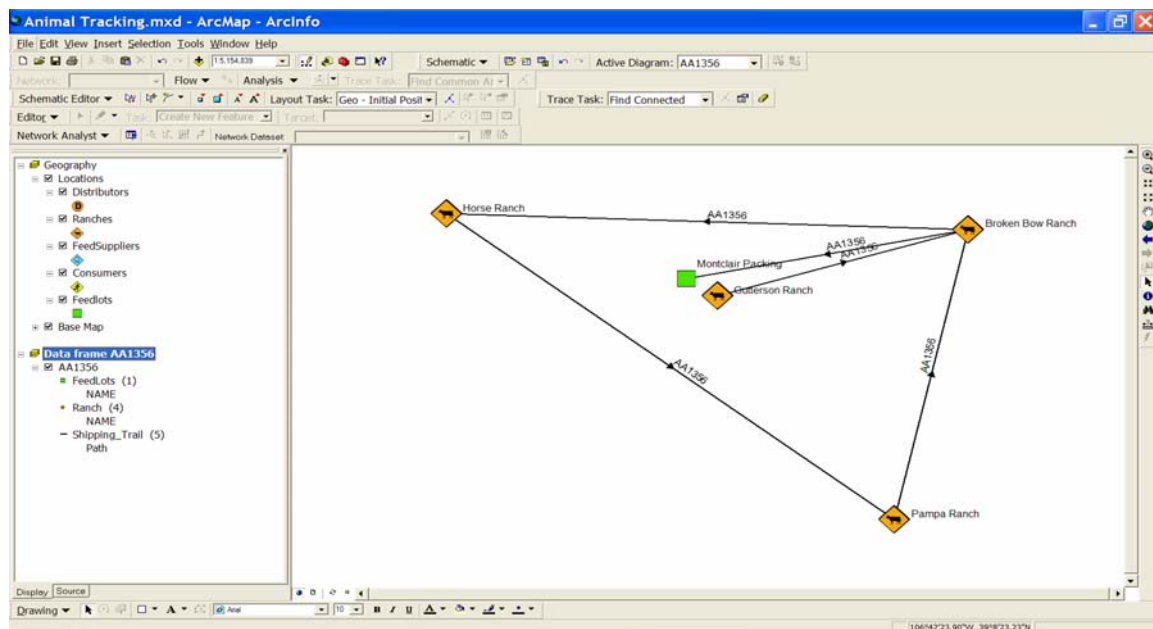
The creation of NPIR is an ambitious undertaking, containing records for every premise in the United States. Managing the added complexities of location edits and modifications, coordinate mapping, multi-coordinate associations with a premises, and the use of shape files associated with premises boundaries, require the "spatial enabling" of the NPIR database. USDA will want to consider a strategy of storing multiple, historical addresses and spatial data for a given premise, as it will assist in understanding and managing the movement of premises and the transfer of sites between premise owners. ArcSDE can be used to create a geodatabase repository that allows for the successful storage and retrieval of the complex spatial information associated with each premises.

Animal Movement and Analysis System

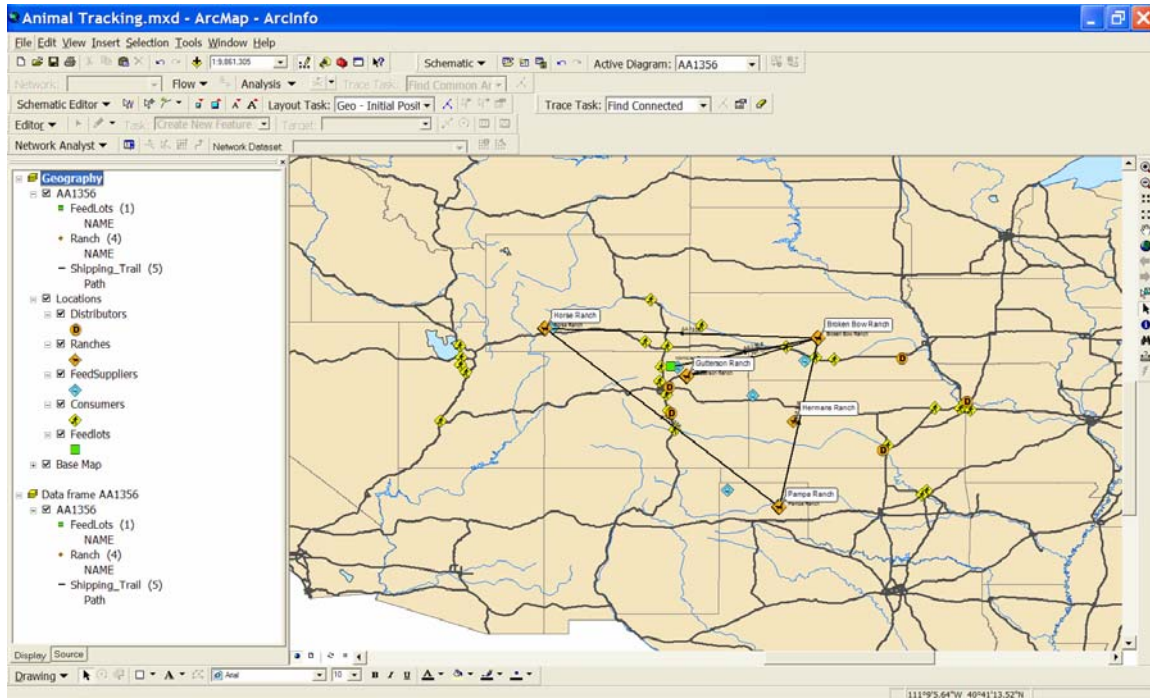
While much direction has been provided by USDA/APHIS relative to the collection of registered premises information, and the reporting of animal movement by receiving premises, much less guidance has been provided regarding specific methods for using this information during disease outbreaks and agricultural emergencies. While the NAIS guidance clearly defines the role of state jurisdictions in registering premises and administering the intrastate transport of animals, it does not specify the role of states concerning the analysis of, and coordinated response to, these emergency events.

ESRI's ArcGIS Schematics extension offers a solution that would enable both USDA/APHIS and states to visualize collected premises and animal movement information for analysis and decision making during emergencies. ArcGIS Schematics can provide the graphical representation of both animal movements, and the intersections of different animal movements at premise locations, as well as the geographical representation of this same information, as depicted below:

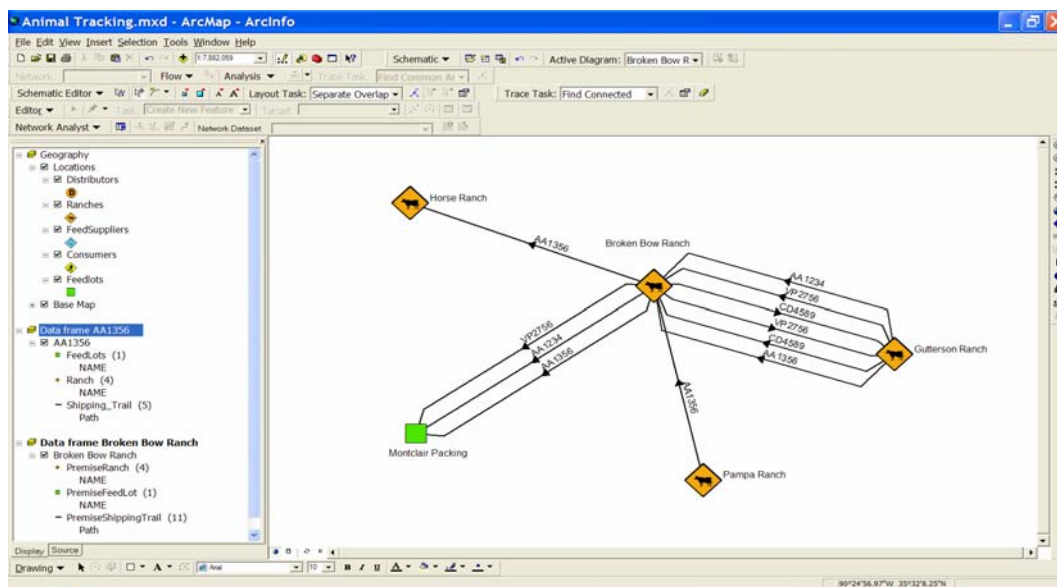
This example depicts how the movement of an animal or animal groups/lots can be represented, using AIN and PIN information collected from multiple receiving premises:



This next example depicts the same animal movement represented geographically, using latitude and longitude coordinates from the geocoded address or identified location of premises:



This final example depicts how the directional movements of all animals or groups/lots associated with a particular premises can be represented:



Given the complexity and volume of animal movement data to be analyzed during an outbreak or emergency, graphical and geographical representation of the information is necessary to quickly use this information for decision-making. Geographical representation allows this information to be used in conjunction with other spatially-enabled data sets in a coordinated, multi-agency response.

ESRI also recommends that USDA/APHIS consider two changes/enhancements to the current NAIS program, relative to animal tracking, requiring the inclusion of both source and receiving facility PIN with each mandated report, and the provision of a data export function for both SPRS and SAIT systems, provided by USDA/APHIS for use by states.

Animal Movement Reporting

The NAIS guidance specifies that the reporting of animal movements is the sole responsibility of the receiving premises or person responsible for the animals at the receiving premises. The receiving premises are the premises to which animals are moved and at which a responsible party (not necessarily the buyer) would be responsible for reporting that identified animals have arrived.

As seen in the following data element table for NARR, inclusion of the PIN associated with the animal movement is not required, only the PIN of the receiving facility:

National Animal Records Repository – Individual Animal Data Elements				
Field Description	Data Type	Size	Reqd.	Example
Event Type Code	Numeric	2	Y	1 (see following event code table)
Sighting/Reporting Premises Identification	Character	7	Y	
Source/Destination Premises Identification	Character	7	N	
Event Date & Time	Numeric	12	Y	YYYYMMDDHHMM 200308011223
Animal Identification number	Numeric	15	Y *	AIN with leading "840"
Species	Character	3	N	
Identification Electronically Read	Boolean	1	Y	0 (False default) / 1 (True)
Animal Date of Birth	Character	8	N	YYYYMMDD 20020101
Age of Animal	Character	3	N	(M)onth, (D)ay, (Y)ear e.g. M11 (Zero fill if less than 10)
Gender	Character	1	N	(M)ale, (F)emale, (C)astrated/neutered male, (S)payed/neutered female
Breed of Animal	Character	2	N	See document Breed codes US and Can1.pdf
Remarks	Character	50	N	Description/other comments (may include brand information)
Status	Character	1	N	(C)orrection
Alternate Animal ID 1	Character	17	N *	Alternate official identification number if 840 AIN not available, Lot identification number if animal has AIN number and was moved out of a lot, old AIN number if tag replaced
Alternate Animal ID Type 1	Character	1	N	(A) AIN with leading USA, (U)SDA eartag, (R) AIN with lead manufacture code, (B)reed registry number, (G)GIN,

				(T)attoo, required if alternate identification (field 15) is provided, R(E)placement AIN number if event code 6 used
Alternate Animal ID 2	Character	17	N *	Second alternate official Identification number if 840 AIN not available, or GIN if animal has AIN and was moved out of a lot
Alternate Animal ID Type 2	Character	1	N	(A) AIN with leading USA, (U)SDA eartag, (R) AIN with lead manufacture code, (B)reed registry number, (L)ot number, (T)attoo, required if alternate identification (field 17) is provided
* At least one official ID required				
Table 6				

This introduces the possibility of gaps in the animal movement history, and less available information to address any gaps in reporting by historical surveillance approaches. In addition, since the location information associated with premises is stored in NPIR, and not in NARR, the requirement of a source facility PIN ensures that linkages can be made more quickly to visually represent an animal movement history.

SPRS/SAITS Data Export Capability

States that utilize SPRS and SAITS, instead of developing their own premises and animal tracking systems, will require data export capabilities so that they are able to import the collected information into other software tools for reporting and analysis. It is unclear to what extent USDA/APHIS will directly provide tools for the states to do reporting and analysis. ESRI can assist USDA/APHIS in the development of standard reporting and analysis tools that are deployable to state jurisdictions as part of the overall SPRS and SAITS offerings.

Proposed GIS-Enabled NAIS Architecture

The NAIS architecture has been established to enable USDA/APHIS to meet the following identified parameters for a successful NAIS, namely:

- Administer Premises Number Allocator.
- Provide a Standardized Premises Registration System and Standardized Animal Identification and Tracking System.
- Enable other compliant Premises Registration and Animal Identification and Tracking Systems developed by States and/or third parties to integrate and exchange information with NAIS.
- Administer National Premises Information Repository.
- Administer allocation of AINs and GINs.
- Administer National Animal Records Repository.
- Meet a 48 hour standard for animal movement reporting to APHIS.

ESRI believes that in order to achieve these objectives, the following parameters also must be met. They are:

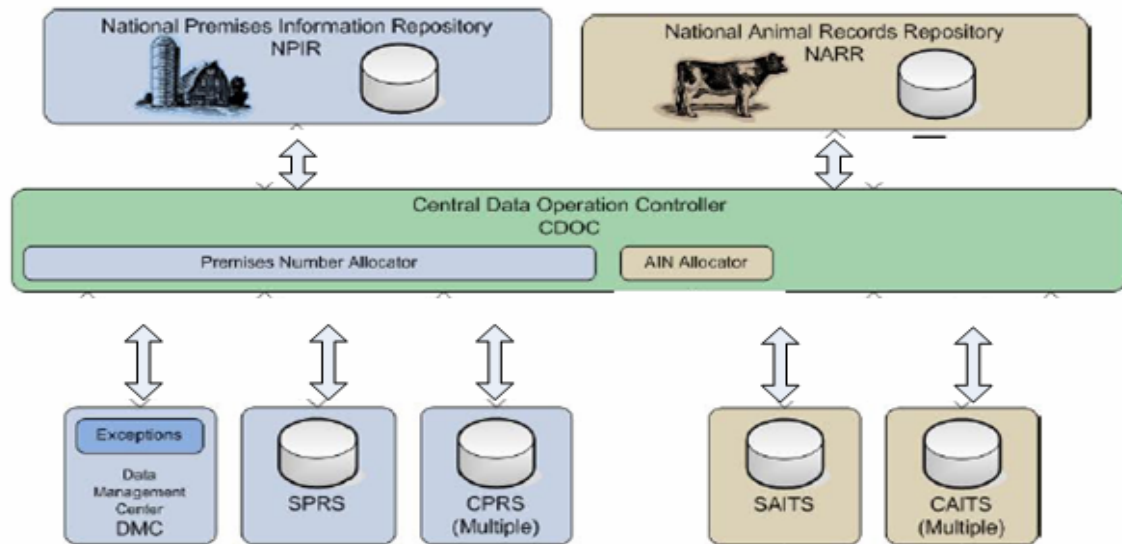
- Provide a web service that ensures that addresses are being normalized and that X-Y coordinates for locations are being properly represented on the base map.
- Develop a geodatabase to assist in monitoring large volumes of premises location information reported to USDA/APHIS.
- Provide GIS tools that facilitate the presentation and analysis of animal movements during emergencies.

A GIS-enabled NAIS architecture will:

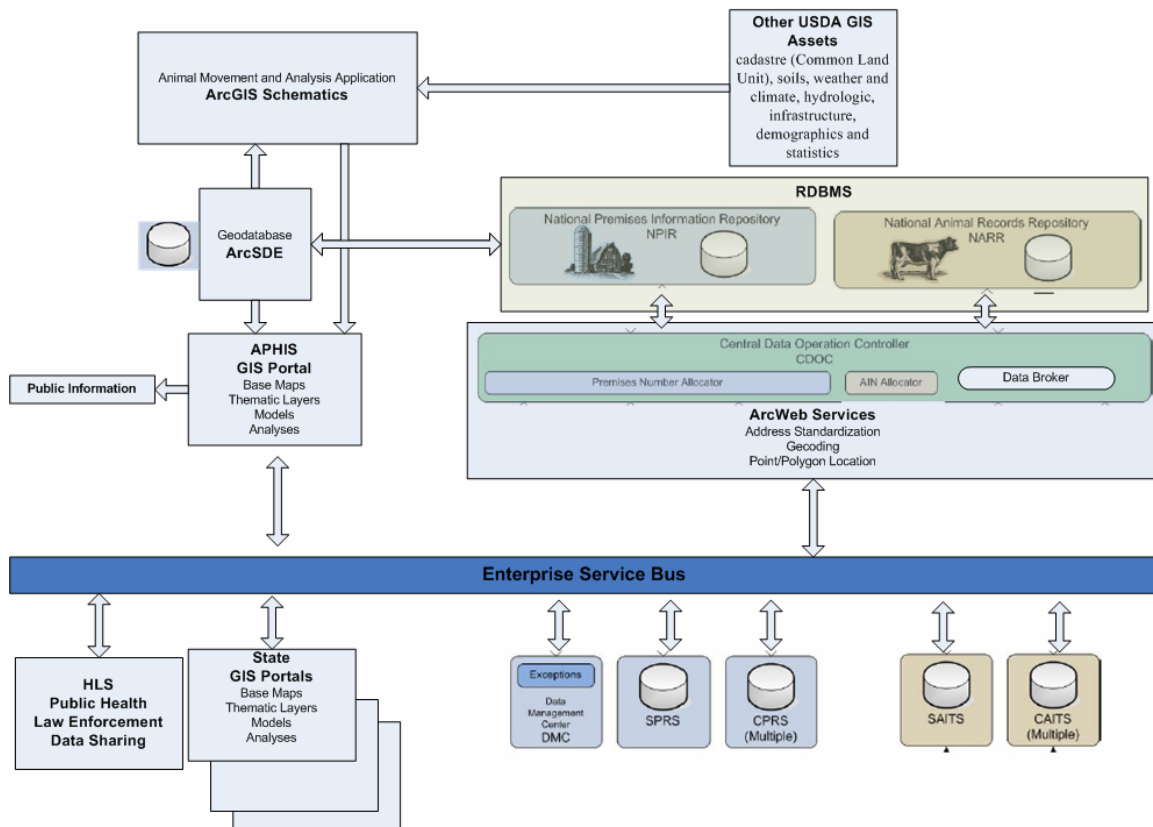
- Enable the sharing of maps, spatial analyses, and other GIS information, between and among APHIS and other government jurisdictions.
- Improve the quality of data collected, minimize redundant work across agencies, and facilitate rapid communications during emergencies.

The following diagrams describe how GIS components would integrate with the NAIS architecture:

Current NAIS Architecture

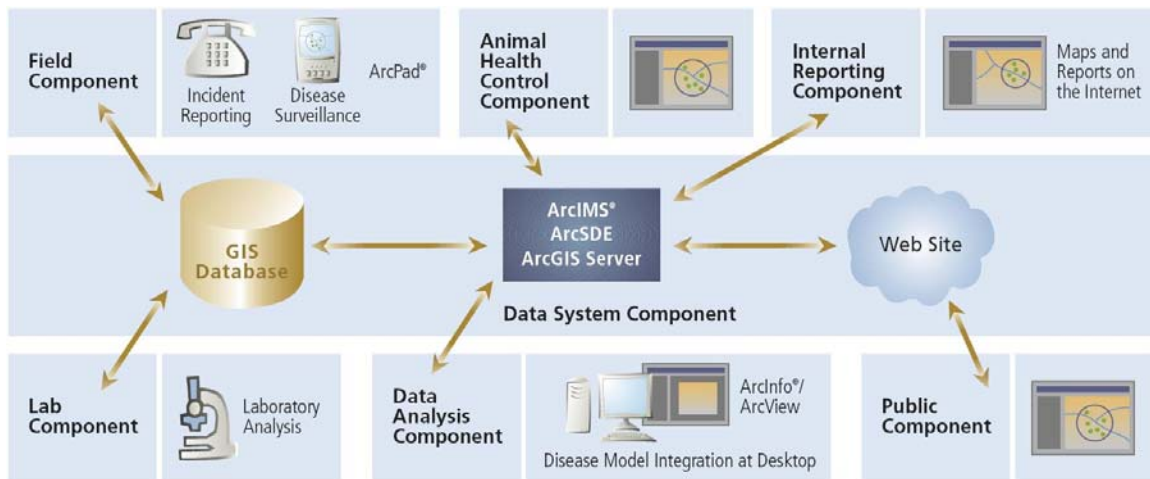


GIS-Enabled NAIS Architecture



Future Steps: Building an Animal Health Surveillance System

An Animal Health Surveillance System utilizes premises and animal movement information as part of a broader information system that integrates laboratory and field information, exchanges information with other response agencies, alerts the agricultural community, and provides information to the public.



The Core NAIS System

Starting with the Premises Identification Component

USDA has acknowledged location as a critical component of NAIS through premises identification. In fact, USDA has indicated that the first step in implementing NAIS is identifying and registering premises that are associated with the animal agriculture industry.

Inventory and Data Repository

The Core of NAIS revolves around a series of data repositories that include the National Animal Record Repository and the National Premises Identification Repository. These systems are joined by the PIN for each registered premises. Associated with these core repositories are inventory systems collecting data such as animal species, birth, official tests and vaccinations. The tracking of interstate and intrastate movement, changes in ownership, and movement through markets and slaughterhouses requires data repositories that allow quick and easy data extraction as needed for analysis, monitoring and notification in case of disease outbreak.

Additional Components of AHSS

Field Inspection

Collecting data derived from the field and rapidly reporting and updating information bases are critical to identifying situations as they appear; this allows staff to begin the control or eradication of disease outbreaks as soon as the problem is identified. Daily field inspection data can be easily added to a data repository with mobile GIS technology, and important field data can always be kept up-to-date.

Detection and Surveillance

Agricultural products begin in a specific location, move through the market chain, and are ultimately delivered to consumers in a different location. Therefore the need to understand events when and where they occur in a meaningful and clear way is paramount. GIS can be used to integrate information into a

common picture with surveillance and detection activity coordinated through the medium of a dynamic map.

GIS is a critical technology for detection and surveillance. These GIS capabilities include:

- Understanding the spatial relationships of subjects as they move through a country or area
- Understanding the clustering of subjects or, conversely, the dispersion of a group of potential subjects
- Displaying locations of reported incidents that may indicate a biochemical problem

Alert and Notification

Timely alerts and notifications are key components in promoting continued confidence in the nation's animal products both nationally and internationally.

Once a disease outbreak is detected, GIS can quickly display where affected animals and/or products are located. By tracking and/or displaying a radius of the locations along the production and market chain, all key government agencies and commercial entities can be immediately notified of the outbreak and affected areas. With timely communications, agencies can make more informed and effective decisions.

Public Portal

Public information and participation complete AHSS. It provides a mechanism through which the public can be educated on animal products, instructed on what to do and who to contact in the event of an outbreak, and advised on where to go if one suspects he or she has been infected. A public portal also provides a forum for individuals to report suspicious activity or potential threats.

Summary

ESRI, the technology leader in GIS solutions, has 35 years of experience in helping people use geographic tools for spatial analysis. Government, business, and medical professionals can leverage this experience to deploy geographic knowledge on the desktop, across the enterprise, in mobile devices, and on the Web through online portals and mapping services.

ESRI believes that the tracking of animals in the entire food production chain across the United States is a challenge best approached through the integration of GIS technology. The incorporation of GIS capabilities into the existing NAIS architecture ensure that USDA/APHIS will be able to meet the overall objective of being able to construct the movement history of an animal within 48 hours during agricultural emergencies.

USDA/APHIS and ESRI both understand the unique challenges and requirements in every state jurisdiction, and USDA/APHIS has provided states with the flexibility to develop their own systems as an option, in accordance with NAIS standards. At the same time, the sharing of common datasets and the exchange of information within and between state systems, and between state systems and NAIS must be assured.

For geographic data, the implementation of GIS portals at both the Federal and state levels, complete with metadata catalogs, and role-base access controls that manage security permissions to geographic data, are the best way to facilitate the shared use and exchange of data in a secure manner. This, in combination with the utilization of shared GIS web services that standardize location information capture, and the use of visualization and analysis tools to characterize and respond to incidents, provides the necessary tools to fully implement a National Animal Identification System.